Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

HYDRODICTYON AFRICANUM, A NEW SPECIES

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY 166

SHIGÉO YAMANOUCHI

(WITH SIX FIGURES)

The genus *Hydrodictyon*, as found in Europe, North America, and Asia, has been represented by a single species, *H. reticulatum* (L.) Lagerh. (*H. utriculatum* Roth.). Its normal life history, external appearance, habitat, and size at maturity are quite familiar to students of algae. Although little is known of the cytology of the zoospores and gametes, and the germination of the resting spores and polyeders, the general organization, with some details of the vegetative nuclear divisions and methods of forming spores and starch, have been described by VAUCHER, BRAUN, PRINGSHEIM, ARTARI, KLEBS, TIMBERLAKE, and HARPER.

In April 1912, shortly after Professor CHAMBERLAIN'S return from an extensive trip through Australia and South Africa, some soil was sent to him by Miss EDITH STEPHENS of the South African College. The soil was secured on the Valkenberg Vlei, near Cape Town, and was supposed to contain spores of the liverwort *Riella*. Some individuals of *Riella* appeared in the culture, but in addition to these there appeared a new species of *Hydrodictyon*, which we shall call *H. africanum*. The following description is based upon the material from this culture.

Early in May there appeared on the bottom of the tank, just above the surface of the soil, a number of green spherical bodies of barely recognizable size, which had the general aspect of *Botrydium*. As growth progressed, the spherical bodies, instead of being groups of solitary cells, were seen to be connected into nets. The nets are made up of 60 or more globular cells which form irregular meshes, arranged in hexagons, heptagons, or octagons, or sometimes simply in broken chains. The nets grow rapidly. Each cell does not grow into an ellipsoidal cylinder as in *H. reticulatum*, but remains spherical or oblong. The cells have remarkable turgidity, so that when the net is supported at one end, the entire plant is kept straight and can be held up in any position without bending or drooping. When the plants grow larger, the turgidity of the cells remains the same, but the connection between cells is by only a small portion of the surface and consequently it is impossible to move the plant without breaking the cells apart. As the plant grows, the connection becomes less and less secure, so that the cells fall apart at the slightest touch or even by a movement of water caused by small crustaceans, until finally the nets are broken apart into solitary cells, or coenobia. During this development, the coenobium has reached an enormous size, the diameter often being more than 1.5 cm. Sketches from living material in successive stages from late April to the middle of June are shown in fig. 1.

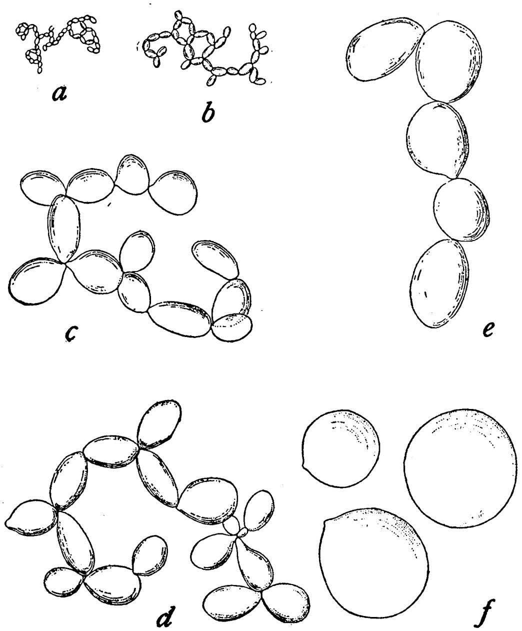

Fig. 1.—*Hydrodictyon africanum*, showing successive stages of development: *a*, May 2, 1912; *b*, May 12; *c*, May 20; *d*, June 12; *e*, June 20; *f*, October 12.—Sketches from living material, natural size.

The dissociated cells remained up to the end of June, and then apparently began to disorganize. Finally they disappeared, and either the entire stock has died or has sunk to the bottom and become buried in the soil in the resting spore or polyeder stage. That the plants should have broken up into solitary cells and that they should have reached such an enormous size might have been thought to be due to the change of environmental conditions, like change in habitat, the gradual change in the density of the water in the tank, or changes in temperature and food. However, another supply of the material, collected in October in the original locality by Miss STEPHENS, showed that the form behaves similarly in nature. This material consists of the various stages as they appeared in the culture, from the young nets of small cells, through broken chains made up of a smaller number of larger cells, to the solitary coenobia. Fig. 1, *f*, shows the last stage, in which the coenobium is slightly larger than those obtained in our own cultures.

It is now clear that the form in nature passes through the same course of development as in our cultures in the laboratory, that is, there is first a net, the cells of which break apart by their own peculiar turgidity and looseness of connection, until finally, the cells which were the sides of the meshes of the net become solitary and live for several months as independent forms. This habit shows most clearly the colonial organization of *Hydrodictyon*.

The soil before starting the culture in the laboratory was not examined for the possible presence of *Hydrodictyon*, but there could be no reason to suspect the previous existence of the plant in the net form in the dried condition, and therefore it must have been in the resting spore condition, characteristic of green algae, or in the polyeder condition, if this form follows the life cycle of *H. reticulatum*, as described by PRINGSHEIM. In any event, we first recognized a rather irregular net coming out of the soil in the tank, which recalls, according to PRINGSHEIM, the product of the germination of a polyeder, though in his description the product consisted of 200–300 cells, while in *H. africanum* there are at most less than 70 cells. The formation of new nets inside the mother cell, which is familiar in *H. reticulatum*, was not observed in this form. The formation of gametes was not observed in the living condition, but was found in fixed material. Consequently, the final product of the coenobium may be gametes, which escape from the cell and after fusion form resting spores. These directly or with the interpolation of a polyeder stage may repeat the cycle.

Not only does this form differ from *H. reticulatum* in size and habit, but there are points of fundamental difference in the structure of the cell, the most remarkable of which are the presence of numerous definite plastids and the formation of starch, not by the fragmentation from the pyrenoid, but in the plastids. These characters which differ from *H. reticulatum* seem to us to be a sufficient basis for a new species, which may very properly be called *Hydrodictyon africanum*.

The general cell structure, nuclear division, and starch formation deserve a brief account. The protoplast of the coenobium is surrounded by a thick wall and occurs as a thin parietal layer, a large vacuole occupying the center. The cell wall consists of three different layers. The protoplasm may be conveniently described as consisting of three parts: *Hautschicht*, the outermost part, directly in contact with the cell wall; plasma membrane, the innermost part which lines the central vacuole; and between these two the main cytoplasmic body, which contains numerous nuclei, plastids, pyrenoids, starch grains, and small vacuoles (fig. 2).

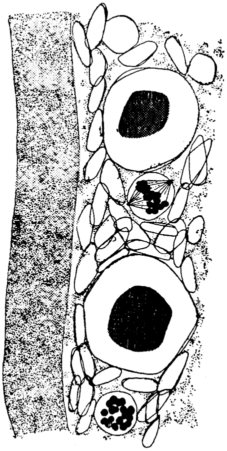

FIG. 2.—Part of a section of a single coenobium: fixed May 20, 1912.—×1500.

The nucleus varies greatly in size at different stages of the division (fig. 3). In the resting stage it is very small, about as large as the shorter diameter of the plastid. It then gradually increases in size. There is a scanty chromatin network and a single nucleolus. When the nucleus has reached its full size, the nuclear network becomes impregnated with a large amount of chromatin. Knots appear in the network and eventually develop into 18 chromosomes. The nuclear membrane is always present until just after metaphase. A centrosome is recognizable from prophase to late anaphase. After telophase, new daughter nuclei are formed, which grow and divide. No case of amitosis was observed. The mitoses in the cell do not take place simultaneously, so that every stage in the division is shown even in a single section of the cell.

The presence of definite chromatophores or plastids has been a matter of discussion among various workers on *H. reticulatum*, but in this new form numerous plastids lie in contact with one another in the middle part of the cytoplasm. The plastid in its earlier stages has an irregular platelike or spindle-like form, and it is denser in the outer region than in the center. A most interesting and important feature in the new form is that the plastids have two functions, one to produce characteristic pyrenoids and the other to form reserve starch grains.

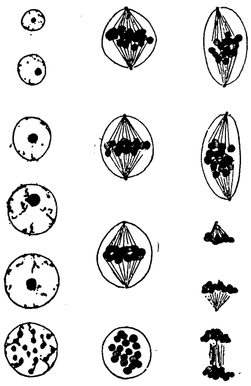

FIG. 3.—Mitotic figures of various stages.—×1500.

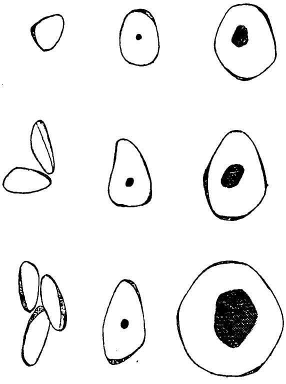

FIG. 4.—Stages showing the formation of pyrenoids from plastids.—×1500.

The formation of pyrenoids from the plastids is as follows. The plastid at first is more dense in the outer part than in the center; and then it increases in size. A deeply staining portion differentiated from the plastid first appears in the center of the body as a small dot, during the growth of the plastid. As the general outline of the plastid grows, the dot also grows, and finally the body of the plastid reaches its full size and assumes a somewhat spherical or slightly angular form; the dot inside also enlarges and assumes a spherical or slightly angular shape. Thus there is established the so-called pyrenoid, spherical in form and consisting of a denser central portion surrounded by the body of the plastid (fig. 4).

The formation of starch grains by the direct fragmentation of the pyrenoid as described by TIMBERLAKE does not occur in this new form. The method of starch formation is as follows. In a part of the body of the plastid near its margin a starch grain is formed either by secretion, as MEYER believes, or in some other way. The starch grain grows and finally reaches a size equal to that of the pyrenoid. The starch thus formed is more abundant toward the plasma membrane (fig. 5).

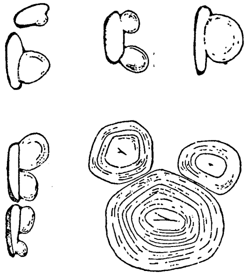

FIG. 5.—Stages showing the formation of starch grains by plastids.—×1500.

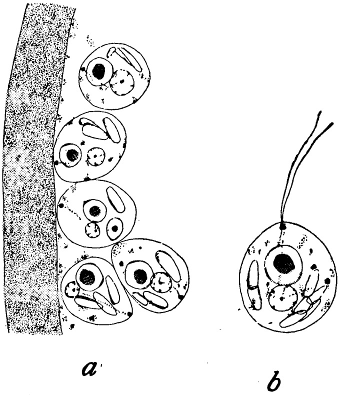

FIG. 6.—Gametes: *a*, part of a section showing the gametes lying near the cell wall, ×1200; *b*, a single gamete, ×1500.

The gamete formation was not observed in living cells, but in fixed material many cases of cells were observed in which a majority of the spores had escaped, still leaving a number of spores within. Whether the spores are zoospores or gametes was not ascertained, but judging from the condition in *H. reticulatum* they should be gametes.

Hydrodictyon africanum Yamonouchi, sp. nov.—Young net of about 60 coenobia; when old, coenobia becoming solitary by breaking apart on account of their great turgidity and loose connections; coenobia deep green, but yellow with age, spherical or oblong, and finally attaining an enormous size, as large as 1.5 cm.; the coenobia live a long time in the solitary condition.

TYPE LOCALITY.—Valkenberg Vlei, near Cape Town, South Africa.

UNIVERSITY OF CHICAGO